FOREST INSECT AND DISEASE MANAGEMENT

Detection of oak mortality on Sherburne National Wildlife Refuge, Minnesota—1979

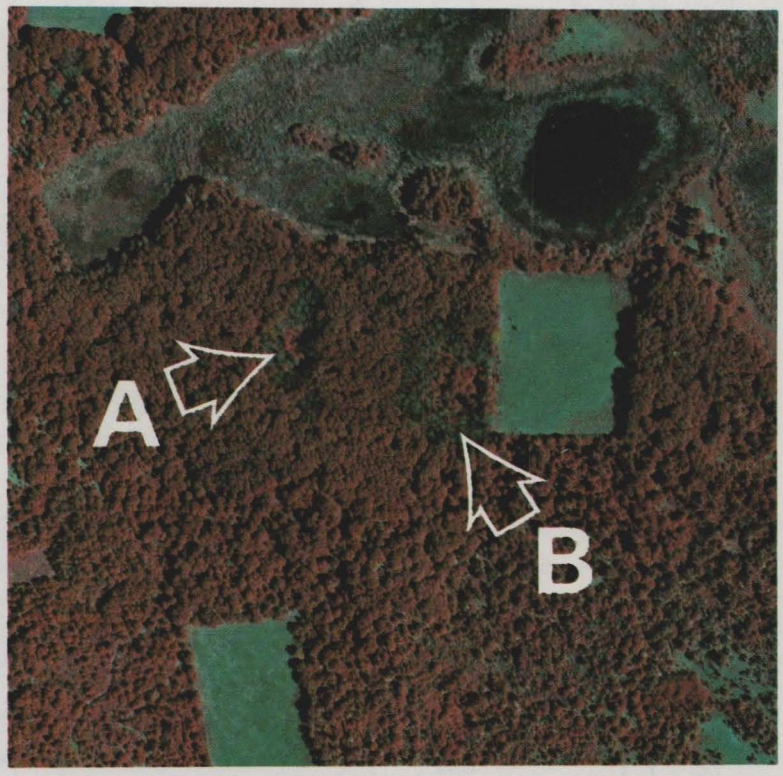

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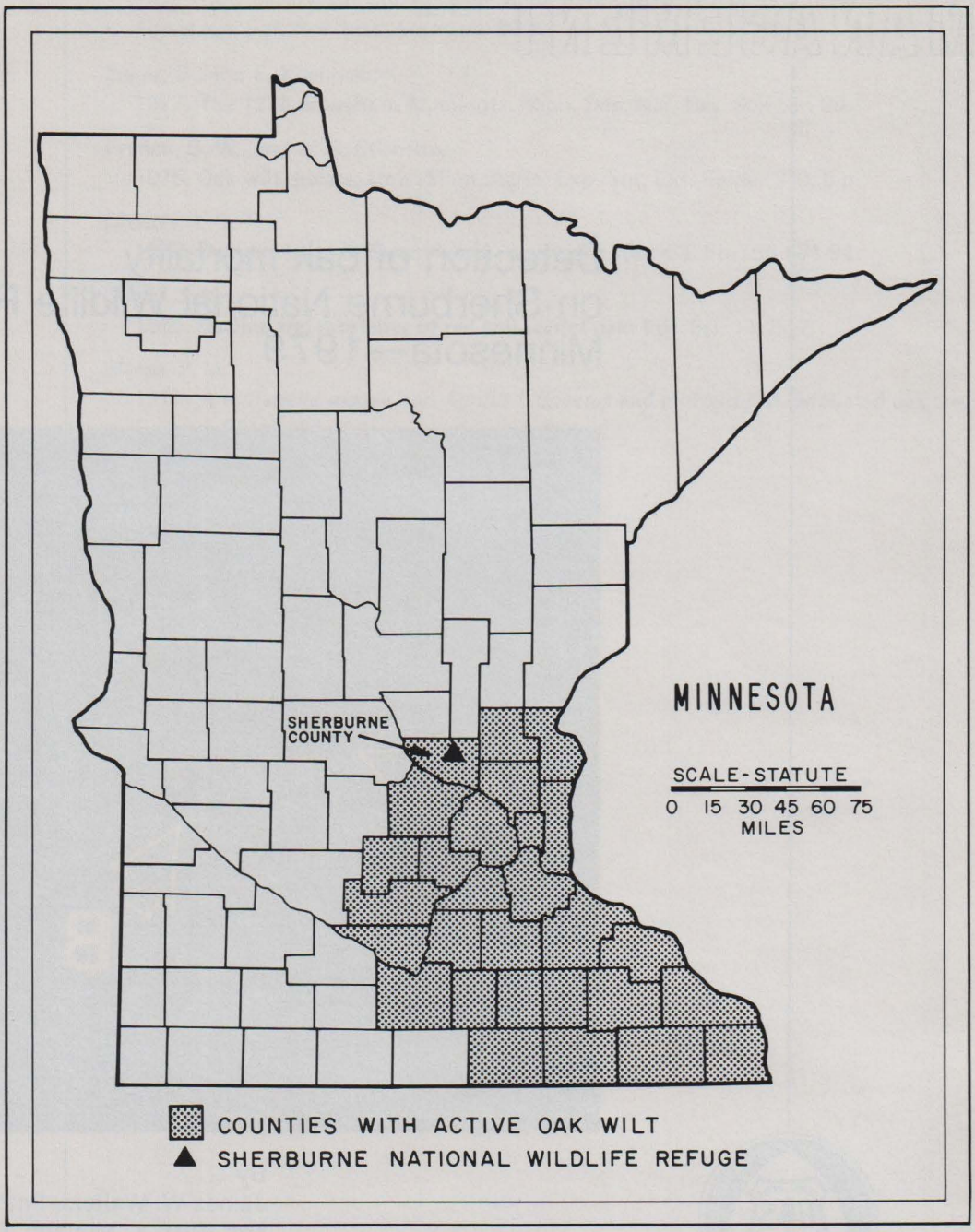
Figure 1.—Counties in Minnesota with active oak wilt.



COVER PHOTO

Oak wilt centers (A and B) were highly visible on the color infrared photographs. Wilting trees appear yellow on infrared photographs.

Oak woodland makes up a part of the 30,552 acre Sherburne National Wildlife Refuge located in Sherburne County, Minnesota. The most prevalent oak species on the refuge are northern red oak (*Quercus rubra* L.), northern pin oak (*Q. ellipsoidalis* E. J. Hill), and bur oak (*Q. macrocarpa* Michx.). Significant oak mortality was detected by refuge managers in 1977 and 1978. At the request of the U.S. Fish and Wildlife Service Regional Forester, a forest insect and disease specialist made a field trip to the refuge in May 1978. A ground check of one large mortality center revealed the presence of oak wilt (*Ceratocystis fagacearum* (Bretz) Hunt). Pockets of dead and dying oaks were noted throughout the refuge woodlands.

A survey was needed to determine the cause of oak mortality and the extent of oak wilt on refuge lands. Refuge administrators were particularly concerned about the amount of oak wilt in their oak woodlands and the potential for spread of the disease to adjacent private lands. Oak wilt is one of the primary causes of oak mortality in Minnesota. Host species for oak wilt in the State include northern red oak, northern pin oak, bur oak, and white oak (*Q. alba* L.). The disease is active in at least 28 counties (French and Stienstra 1975), including Sherburne County (Fig. 1).

The objective of this survey was to determine the incidence, location, and cause of oak mortality centers on Sherburne National Wildlife Refuge.

METHODS

Aerial photographs of the Sherburne National Wildlife Refuge were taken during August 1979. Photographs were taken at a scale of 1:8000 in a 9 x 9 inch format. Color infrared film (type 2443) and a Wratten 12 filter were used. Photography was done by Mark Hurd Aerial Surveys, Inc. of Minneapolis.[1] Photo interpretation was done at the Forest Insect and Disease Management laboratory in St. Paul.

An Old Delft stereoscope set at 4.5 power over a light table was used for the photo interpretation. Tree mortality centers on each transparency were outlined on acetate overlays. Centers were numbered, classified as single-tree or clustered (i.e., two or more affected trees within 40 feet of each other), and identified as oak wilt or other mortality. The number of dead and wilted trees per cluster was recorded for each photo. Suspected oak wilt centers were identified by their ringlike pattern, with dead trees in the center and wilting trees along the edge (cover photo). Wilting or fading trees were identified on the photos by their yellow color. Accessible clusters having one or more wilted trees were ground checked. Due to the difficulty of location and time constraints, no single trees were ground checked.

During late September, oak trees in each ground-check cluster were examined to determine the cause of death. Tree species and the primary mortality factor or factors were recorded for each cluster. Criteria used to determine presence of oak wilt were: 1) the presence of a fungal (mycelial) mat or pad between bark and wood, 2) discolora-

[1] The use of trade, firm, or corporation names in this paper is for the information and convenience of the reader. Such use does not constitute official endorsement or approval by the U. S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

tion in outer sapwood and/or a fermenting odor, 3) the presence of wilted leaves and the portion of tree crown that had wilted leaves, 4) a ringlike pattern of the infection center. In clusters where oak wilt was recorded as the primary mortality factor, samples were collected for laboratory confirmation of the field diagnosis.

RESULTS

A total of 6,982 dead trees and 294 wilted trees were identified by photo interpretation. Dead and wilted trees were distributed in 344 clustered and 263 single tree centers. The clusters accounted for 6,733 dead trees and 280 wilted trees. Fourteen of the single trees were wilted and the remainder were dead. On the basis of photo interpretation, three clusters were considered oak wilt centers and the remainder classed as other mortality.

Forty-four clusters, including the three potential oak wilt centers were ground checked. Ground-checked clusters represented 2,376 dead or wilted trees. The primary tree species in most of the clusters were pole- to sawtimber-size northern red oak and northern pin oak. Of the 44 clusters, two were American elm and tree mortality was caused by Dutch elm disease (*Ceratocystis ulmi* (Buism.) C. Mor.). Primary mortality agents for the remaining 42 clusters are:

Mortality factors	*Number of clusters*	*Number of trees*
Twolined chestnut borer[a] and Armillaria root rot[b]	36	2,181
Oak wilt	2	140
Windthrow	1	28
Fire	2	25
Lightning	1	2

[a] *Agrilus bilineatus* (Weber)

[b] *Armillariella mellea* (Vahl ex Fr.) Karst

DISCUSSION

The major cause of tree mortality on Sherburne refuge was oak decline. Oak decline (Fig. 2) is associated with a number of factors that contribute to the death of affected trees. On Sherburne refuge, these factors were drought stress, the twolined chestnut borer, (Figs. 3-4) and Armillaria root rot (Fig. 5). The twolined chestnut borer and Armillaria root rot usually are considered secondary mortality agents. However, trees that are stressed by a factor such as drought often are predisposed to attack by secondary insects or diseases. The sequence of events associated with oak decline has been documented in other areas (Abrahamson 1977, Nichols 1968, Staley 1965, Wargo 1977).

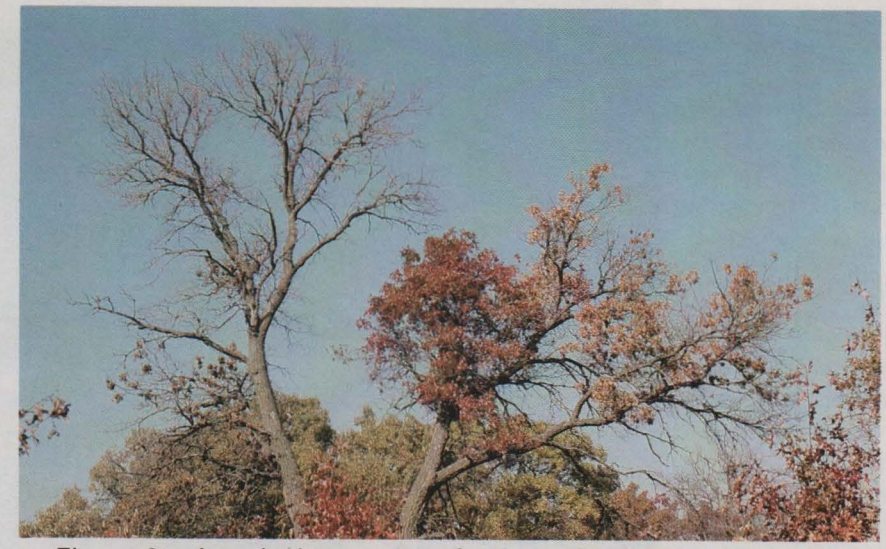


Figure 2.—A typical symptom of oak decline is the gradual die-back of branches in the tree crown.

Figure 3.—A group of oak trees killed by the twolined chestnut borer.

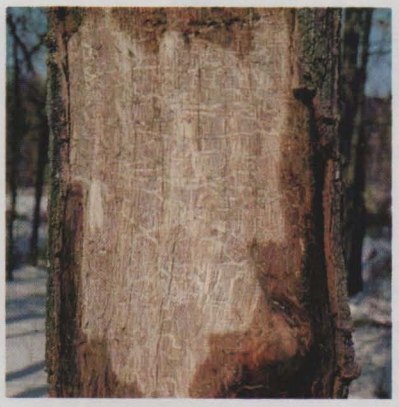


Figure 4.—Galleries of the two-lined chestnut borer wind in all directions.

Figure 5.—Armillaria root rot is easily identified by white mycelial fans between bark and wood at the root collar.

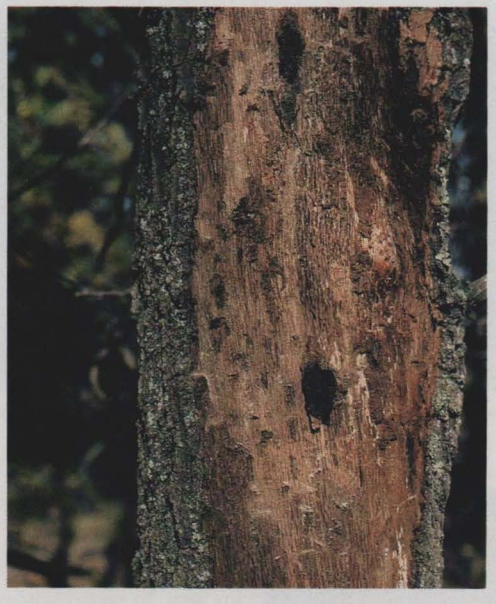


Figure 6.—The oak wilt fungus forms a pressure pad that pushes the bark open so that spores can be disseminated from an infected tree.

The pattern of tree decline and mortality on Sherburne refuge was characteristic of oak decline induced by drought stress. The decline of most oak trees examined had occurred over a period of about 3 years. Two distinct time intervals were associated with the decline. The top 30 to 40 percent of an affected tree died in 1976-77 or 1977-78, the middle to lower crown died in 1977-78 or 1978-79, and the remainder of the tree died in 1978-79 or was still alive and will die in 1980. In 1976, Minnesota suffered

the most severe drought in the 60 years that records have been maintained (Baker and Kuehnast 1977). The effects of the drought probably predisposed oak trees to attack by the twolined chestnut borer. As the borers infested more of the tree, stress increased and Armillaria root rot became increasingly active. The final result was death of the tree, caused by this complex of insect and disease agents.

Very little recent top decline was found during our field examinations, indicating that the sequence of events associated with oak decline has neared its completion. Thus, the extensive oak mortality now occurring on Sherburne refuge should subside in 1980. The two clusters infected with oak wilt (Fig. 6) were about 100 yards apart and appeared to be well established. Each center had 15 to 20 wilted trees around the perimeter, indicating substantial spread of the disease in 1979. The oak wilt centers were located near the southern boundary of the refuge in a mixed hardwood stand.

Spread of the disease can be expected to continue if left untreated. The oak wilt fungus spreads in two ways. Local spread is by transmission of the fungus through root grafts between infected and healthy trees. Long-distance spread is primarily vectored by sap-feeding insects of the family Nitidulidae. Both local and long-distance spread of the disease can be anticipated in the two centers that were identified. The scattered nature of oak woodlands on the refuge should minimize the spread of oak wilt. However, insect vectors could spread the disease to woodlands adjacent to the refuge.

Aerial photography was useful for detecting oak mortality centers. Comparison of photo interpretation results and ground-check data show a 2.3 percent error (1 of 44) in differentiating oak wilt-caused mortality from other oak mortality. Detecting mortality of tree species other than oak occurred 4.5 percent (2 of 44) of the time. Neither type of photo interpretation error had a significant effect on the results of this survey.

CONCLUSION

The primary cause of oak mortality on Sherburne National Wildlife Refuge was oak decline. All identified clusters were plotted on aerial photos and a refuge map. This information was provided to the refuge manager. Oak wilt was found in two clusters near the southern boundary of the refuge. Without treatment, the disease can be expected to continue spreading. However, spread should be at a relatively slow rate because of the scattered nature of oak woodlands on the refuge. Techniques for control of oak wilt are available and will be provided to the refuge manager upon request.

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